Testing of a Cellphone-based Cosmic-ray Detector Network

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Abstract

The purpose of this project was to measure cosmic rays using phone cameras and the Distributed Electronic Cosmic-Ray Observatory (DECO) application as a low-cost monitoring network that is part of the Global Sensor Web. DECO is able to detect cosmic rays using the Charge Coupled Devices (CCD) on the camera on a phone. Issues with thermal flare triggering erroneous data acquisition on the phones has been an issue since the start of the project and this study served to isolate them from cosmic ray events.

Introduction

Cosmic rays are energetic subatomic particles which impact the Earth from an extraterrestrial source. Most of these particles do not directly reach the Earth's surface, but are indirectly detected by their secondary particles produced in collisions in the upper atmosphere (Fig 3). These particles are studied for various reasons, from using relatively low-energy rays to monitor solar flares to using the highest energy particles are probes of physics beyond the Standard Model. As flux drops quickly with energy it becomes necessary to create large detector arrays, which has provided the motivation to use the near-ubiquitous hardware found in phone to make a large distributed detector network.

Apparatus

15 cell phones of varying models running the Android OS and DECO app were used to collect data for this study. Phones would log data internally and on a remote server for later image recovery and analysis of potential events.

Figure 1- An example event (magnified with color range compressed)

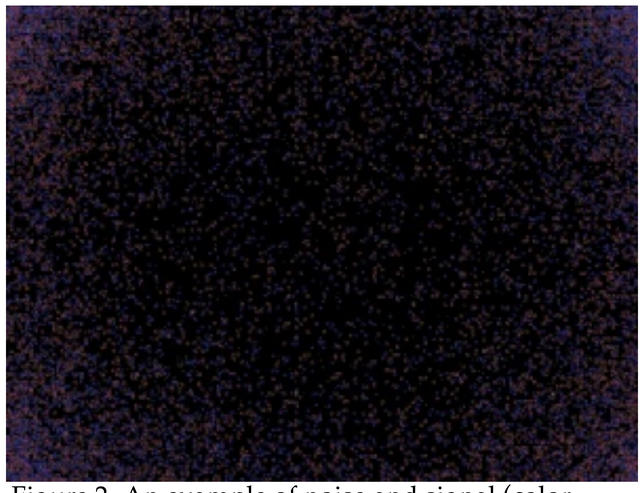


Figure 2- An example of noise and signal (color range compressed)

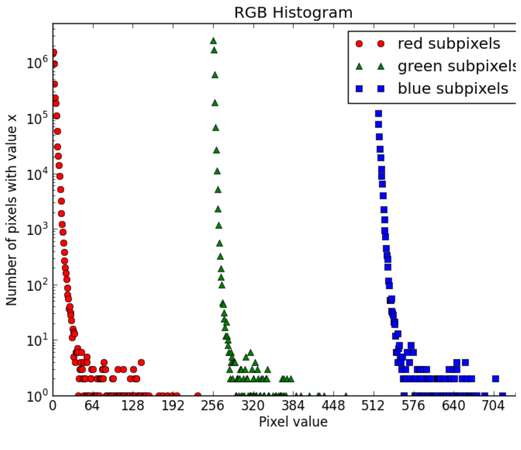


Figure 4- Histogram of cosmic ray event

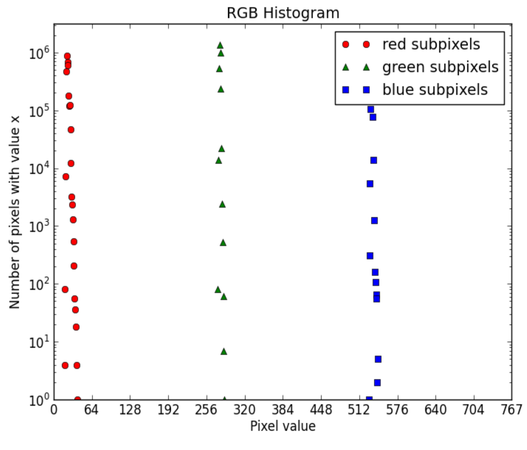
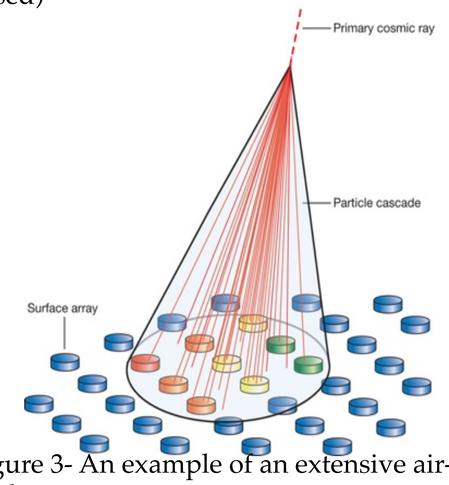


Figure 5- Histogram of thermal flare



'igure 3- An example of an extensive air-shower With ground-based detectors.

Experimental Set-up

The phones were all running the DECO app which is responsible for using the phone's camera to detect high energy events. The app has the camera take images every few seconds, then filters out events based on the number of pixels in the image and their intensity value. Then DECO app passes it onto the datalogger, which is responsible for communicating the data from the phone to the primary Global Sensor Web server. These images, and the associated phone sensor data, are then archived on a daily basis. This associated sensor data, such as the onboard GPS receiver and magnetometer, are then used to help search for potential correlations between event rate and the phone's environment as well as helping in the search for extensive air showers.

Analysis

positives triggered through thermal flare was the main focus of this study. This was achieved through numerical image analysis. Each pixel contains 4 sub-pixels, one red, one blue, and two green, each of whose exposure value is measured by an integer from 0-255. These values were then used to discriminate low exposure value thermal flares from higher-energy and exposure value cosmic ray events. For any image if any of the four sub-pixel exposure values for any pixel were greater than or equal to 150 results were treated as genuine and from actual cosmic ray events. The value of 150 was decided on after careful manual analysis of actual and erroneous data. This filter also achieved the effect of discriminating against erroneous data capture resulting from stuck pixels. One goal of future research will be differentiating cosmic ray exposures from lower-energy electron "worms" and higher-energy muon "tracks".

References

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